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| APPLICATION NO.   | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
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| 10/573,864  | 05/05/2006  | Wulf Nagel           | 04156.0022U1        | 7070             |
| 23859 7590 05/19/2009<br>Ballard Spahr Andrews & Ingersoll, LLP<br>SUITE 1000<br>999 PEACHTREE STREET<br>ATLANTA, GA 30309-3915 |             |                      |                     |                  |
| EXAMINER<br>TRINH, THANH TRUC   |             |                      |                     |                  |
| ART UNIT  |             | PAPER NUMBER         |                     |                  |
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**Please find below and/or attached an Office communication concerning this application or proceeding.**

The time period for reply, if any, is set in the attached communication.

### Office Action Summary

**Application No.**

10/573,864

**Applicant(s)**

NAGEL, WULF

**Examiner**

THANH-TRUC TRINH

**Art Unit**

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**Period for Reply** -- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

- 1) ☒ Responsive to communication(s) filed on 24 April 2009.  
2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.  
3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

- 4) ☒ Claim(s) 1-2, 4-7, 9, 12-17 is/are pending in the application.  
4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.  
5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.  
6) ☒ Claim(s) 1, 2, 4-7, 9 and 12-17 is/are rejected.  
7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.  
8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

**Application Papers**

- 9) ☐ The specification is objected to by the Examiner.  
10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).  
11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).  
a) ☐ All b) ☐ Some \* c) ☐ None of:  
1. ☐ Certified copies of the priority documents have been received.  
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.  
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

- 1) ☒ Notice of References Cited (PTO-892)  
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)  
3) ☐ Information Disclosure Statement(s) (PTO-8508)  
Paper No(s)/Mail Date \_\_\_\_\_  
4) ☐ Interview Summary (PTO-413)  
Paper No(s)/Mail Date \_\_\_\_\_  
5) ☐ Notice of Informal Patent Application  
6) ☐ Other: \_\_\_\_\_

## **DETAILED ACTION**

### ***Continued Examination Under 37 CFR 1.114***

A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 4/24/2009 has been entered.

### ***Remark***

1. Claims 1-2, 4-7, 9, 12-17 are pending in the application. Claim 17 has not been further treated on the merits, because it is invalid as depending on a canceled claim.

### ***Claim Rejections - 35 USC § 112***

2. The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

3. Claims 1-2, 4-7, 9 and 12-16 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention.

As amended, claim 1 recites the limitation "the volume ratio of the photo absorber to at least one conductor is in the range of between 2 to 7" in lines 10-11. There is no support found for this limitation in the originally filed disclosure. In page 3, 2nd paragraph, Applicant describes the volume ratio of the photon absorber to the conductors is in the range between 2-7, and "the conductors" are as in plural form. Applicant does not describe "the volume ratio of the photon absorber to at least one conductor is in the range of between 2 to 7" (emphasis added) any where in the originally filed disclosure.

Claims 2, 4-7, 9 and 12-16 are rejected on the same ground as claim 1.

4. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

5. Claim 17 is rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Claim 17 depends on claim 8 which is canceled. Therefore claim 17 is indefinite as being invalid. Accordingly, the claim 17 has not been further treated on the merits.

### ***Claim Rejections - 35 USC § 103***

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and

the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
  2. Ascertaining the differences between the prior art and the claims at issue.
  3. Resolving the level of ordinary skill in the pertinent art.
  4. Considering objective evidence present in the application indicating obviousness or nonobviousness.
6. Claims 1-2, 4 and 12 are rejected under 35 U.S.C. 103(a) as being unpatentable over Mauk (US Patent 5828088) in view of Wenham et al. (US 4748130) and further in view of Epstein (US Patent 3664874)

Regarding claim 1, as seen in Figures 1-3, Mauk teaches a photovoltaic element comprising a photon absorber (including layers GaAs substrate, epitaxial layers p-type cladding layer, p-type base, n-type emitter); an electrically conductive large-surface working element (buried mirrors or reflective mask) made of refractory metals such as tungsten (See col. 7 line 60 through col. 8 line 67), wherein the working element is a parallelepiped (see figures 1A-B and 3) and separated from the photon absorber by a phase boundary (i.e. different material) and has a greater electron mobility than the photon absorber. Mauk also teaches the photon absorber (or solar cell) can be made with GaAs or silicon (See col. 3 lines 17-20, col. 7 lines 40-49).

Mauk does not teach at least one conductor embedded in the photon absorber, the volume ratio of the photon absorber to at least one conductor is in the range of 2-7, and the one conductor has essentially the same composition as the working element.

Wenham et al. teaches forming buried contact layers (metallization of grooves 13 as seen in Figure 1, fingers and busbars - See col. 3 line 20 through col. 4 line 55); wherein buried contact layers (or instant conductors) are formed on both sides (front and back) of the silicon wafer (see sequence B), the ratio of width to depth of the grooves for filling the metal material is 1:2-1:7 (see col. 3 lines 41-50), and finger spacing is from 1.5-2.5mm (see col. 4 lines 1-16). It is found that the volume ratio of total conductors (front and back) to the photon absorber (or single crystal silicon substrate) to be 2-7.

Epstein teaches tungsten can be used as electrical contacts on silicon substrates (See abstract, col. 1 line 4 through col. 3 line 26).

It would have been obvious to one skilled in the art at the time the invention was made to modify the photovoltaic element of Mauk by having conductors embedded in the photon absorber and the volume ratio of the conductors to the photon absorber is between 2 to 7 as taught by Wenham et al., and using tungsten as the material for the conductors in silicon photon absorber as taught by Epstein, because Wenham et al. teaches such conductors would reduce the shading area (see abstract of Wenham et al.) and Epstein teaches tungsten would withstand the extreme environment conditions of temperature, humidity, vacuum and radiation (See col. 2 lines 18-20 of Epstein). In

such combination, the conductors are made of tungsten which is the same composition as the tungsten working element taught by Mauk.

Regarding claim 2, the work element of Mauk is a buried mirror, and is substantially electrically insulated from a positive and a negative pole of the photovoltaic element (e.g. emitter contact or back contact)

Regarding claim 4, Mauk teaches the working element (buried mirror of reflective mask) running from one side edge (e.g. the front of the page side edge) to the opposite side edge (e.g. back of the page side edge) of the solar cell as seen in Figures 1A-B. Wenham et al. describes a conductor is formed by filling metal material in a groove with cross section as seen in Figures 1, 2a-c, or the groove is running from the front of page to the back of page. Therefore, in the combination of Mauk in view of Wenham et al. and Epstein, the working element and the conductor is elongate and substantially parallel to each other.

Regarding claim 12, metal such as tungsten is from the 3.-6. main group and has electron configuration of d-layer occupied by ten electrons. The conductivity of tungsten is  $176.991 \times 10^3 \Omega^{-1}\text{cm}^{-1}$  (See Tungsten element facts provided by Chemicool.com) which is inherently higher than  $1.4 \Omega^{-1}\text{cm}^{-1}$ .

7. Claim 5 is rejected under 35 U.S.C. 103(a) as being unpatentable over Mauk in view of Wenham et al. and Epstein, and further in view of Wenham et al. (US Patent 5595607, hereby '607)

Mauk in view of Wenham et al. and Epstein teaches a photovoltaic element as applied to claims 1-2, 4 and 12 above, wherein Wenham et al. teaches a plurality of conductors (e.g. grooves to form front or back contacts- see col. 3 line 20 through col. 4 line 55).

Mauk in view of Wenham et al. and Epstein does not specifically teaches a positive conductor ending at or protruding beyond a first front side of the photon absorber, a negative conductor ending at or protruding beyond a second front side of the photon absorber.

'607 teaches a positive conductor (e.g. metal filled groove 305 connecting to p+ material 308 as seen in Figure 1) ending at a first front side of the photon absorber and a negative conductor (e.g. metal filled groove 309 connecting to n+ material as seen in Figure 1) ending at a second front side of the photon absorber (See figure 1)

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the photovoltaic element of Mauk in view of Wenham et al. and Epstein by having a positive conductor ending at a first front side of the photon absorber and a negative conductor ending at a second front side of the photon absorber as taught by '607, because '607 such connecting would provide opposite polarity (e.g. positive and negative) interdigitated with each other to minimize photoactive space lost as well as providing a current path to interconnecting grooves which interconnect the photovoltaic cells at the same time providing for low resistance losses. (see col. 4 lines 7-29 of '607)



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8. Claims 6-7, 9 and 13-16 are rejected under 35 U.S.C. 103(a) as being unpatentable over Mauk in view of Wenham et al., Epstein and '607, and further in view of Warner (US Patent 3994012)

Mauk in view of Wenham, Epstein and '607 teaches a photovoltaic element as described in claims 1 and 5 above, wherein '607 teaches the conductors are embedded in the photon absorber and formed on one side of the photovoltaic element (see Figure 1 of '607)

Mauk in view of Wenham, Epstein and '607 does not teach two photon absorbers are in contact via an abutment surface in which the positive conductors are separated from the negative conductors by the abutment surface; or a plurality of positive conductors are connected with each other through an omnibus and a plurality of negative conductors are connected with each other via a second omnibus conductor; or a plurality of photovoltaic elements arranged in a recess wherein the recess is in contact with at least one photon absorber; or two photon absorbers have a mutually anti-parallel crystal structure.

With respect to claims 6-7, as seen in Figures 15-20 and 32-33, Warner teaches a photovoltaic element having a multi-layer structure, wherein at least two absorbers (right and left columns of multilayers of N and P) are provided in contact via an abutment surface (or the bottom surface of interconnection 45 as seen in Figures 15-20) in which the positive conductors (P+ regions next to the interconnection 45) and the negative conductors (N+ regions next to the interconnection 45) are arranged such that the positive conductors and the negative conductors are separated from each other by

the abutment surface, and the plurality of positive conductors are connected with each other through a first omnibus conductor (or interconnection 45 via comb-like extension 62) and a plurality of negative conductors are connected with each other via a second omnibus conductor(or interconnection 45 via comb-like extension 60).

With respect to claim 9, Warner teaches connecting a plurality of single crystalline semiconductors of photovoltaic cells by series/parallel connection (See Abstract, col. 16 lines 55-68). In such connection of single crystalline photovoltaic cells, the two photon absorbers obviously have mutual anti-parallel crystal structure.

With respect to claims 13-16, as seen in Figures 15-20 and 27-33, Warner teaches a photovoltaic device comprising a receiving element (substrate 40 as seen in Figures 27-33) with recesses in which at least one photovoltaic element (columns of P and N layers) is arranged, wherein conductors (P+ and N+ regions) present in the photovoltaic element are each connected to omnibus conductors (or interconnection 45 as seen in Figures 15-20). Warner also teaches a plurality of photovoltaic elements (absorbers layer of P material and conductors P+ and N+) are arranged in at least one recess, wherein the recess is in contact with at least one photovoltaic element (See Figures 27-33). Warner further teaches a connecting means (interconnection 45) for mechanically and electrically connecting at least two photovoltaic devices arranged side by side, wherein a plurality of first connecting conductors (i.e. comb-like extension 62) and a plurality of second connecting connectors (comb-like extension 60) are each connected with first current conductor (an interconnection 45 as seen in Figure 19) and second current conductor (another interconnection 45 as seen in Figure 19).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the photovoltaic element (or device) of Mauk in view of Wenham et al., Epstein and '607 by having absorbers in contact via an abutment surface, absorbers in recesses and mechanical and electrical connection as taught by Warner, because Warner teaches a photovoltaic cell including all the limitations disclosed by Warner and recited above would increase cell efficiency. (See Abstract of Warner). It would also have been obvious to connect single crystalline photovoltaic cells in series/parallel as taught by Warner to achieve a mutually anti-parallel crystal structure, because Warner teaches such connection is suitable configuration. (See col. 16 lines 55-68).

### ***Response to Arguments***

Applicant's arguments with respect to claims 1-9 and 11-16 have been considered but are moot in view of the new ground(s) of rejection.

### ***Conclusion***

Any inquiry concerning this communication or earlier communications from the examiner should be directed to THANH-TRUC TRINH whose telephone number is (571)272-6594. The examiner can normally be reached on 8:30 am - 5:00 pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nam Nguyen can be reached on 571-272-1342. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Nam X Nguyen/  
Supervisory Patent Examiner, Art Unit 1753

TT  
5/11/2009